Planning and Judging Street Lighting

1930

Revised Edition

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PLANNING AND JUDGING STREET LIGHTING

(1930 Revised Edition)

An Address Delivered before the Annual Convention of the International Association of Municipal Electricians at Augusta, Georgia

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GENERAL ELECTRIC COMPANY
SCHENECTADY, N. Y.

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A NOVALUX FAMILY

An Architectural Family of Street-lighting Units Adopted by Lansing, Mich.,
Augusta, Ga., and Other Cities

Planning and Judging Street Lighting

(1930 Revised Edition)

GOOD street lighting means a better, safer, cleaner city, enhanced property values, and civic progress. It is one of a city's greatest assets.

The basic reason for street lighting is protection, but to-day it is the foundation on which all our nocturnal activities depend. Within useful range of vision, we should be able to see equally as well by night as by day. Only through good lighting can night traffic be accelerated and accidents avoided.

Good lighting may well be termed a sanitary measure, as well-lighted streets are kept cleaner, are less abused, and in fact, react upon the surrounding property and the residents themselves.

Good lighting pays dividends in enhanced property values, increased trade, and in the attraction of desirable residents.

MODERN STREET-LIGHTING PRACTICE

The present tendency in the lighting of our cities is toward ornamental poles and fixtures fed from underground cables. If a street is worth paving it certainly deserves good lighting of an attractive character. Many cities are adopting the slogan of "Ornamental Lighting Standards on Every Paved Street." Conditions often exist, however, where it is impracticable or decidedly uneconomical to place wiring underground, so there have been made available ornamental brackets and luminaires which can be mounted on existing distribution poles. Since the pole line is often lost in the tree line, such an installation may present a satisfactory and pleasing appearance, the brackets and fixtures alone being apparent.

Investments of from five to ten dollars per capita are necessary to remodel and modernize a city's lighting, and such amounts are being expended in a few of our large and many of our small cities.

Modern progressive cities are expending thousands of dollars in the preparation of plans for civic betterment and yet seldom do these plans suggest street-lighting improvements. Traffic can be controlled by good paving and lighting. Business also will follow the line of lights. For these reasons proper street illumination should be included in all zoning plans.

PLANNING STREET LIGHTING

No city is too poor to make an investment in proper street lighting, for it begins immediately to return dividends in the relief of traffic congestion and the saving of millions of dollars in time and in accident reduction. Recent statistics show that twenty per cent of our night-traffic fatalities are directly due to insufficient street illumination.

When municipalities realize that street-lighting expenditures are investments and not merely additions to the budget, they will make appropriations that permit the installation of such lighting as is herein recommended. No progressive city should be spending annually less than two dollars per capita for street lighting, and yet the average to-day is only slightly over half that amount. There are less than fifteen per cent of our cities of over 30,000 population that are spending more than a dollar and fifty cents, and none of these is entirely adequately lighted. Good lighting will come only through budget increases and it is the duty of the municipal officials and civic organizations to point out the wisdom and necessity of such increases.

While there are numerous types of luminaires that can be used successfully for lighting the

The Old and New Types of Street Lighting on Broadway, Saratoga Springs, N. Y. The Old Units Suspended from Mast Arms Have Been Replaced by New Units on Ornamental Standards

streets of a city, these should not be used promiscuously without regard to requirements of the street to be lighted. For instance, the modern business street should have a fixture that will distribute the light over the building facades as well as the pavement, and there may even be a small sacrifice in efficiency in the interest of appearance. On the other hand, in lighting the traffic artery, efficiency is of paramount importance. High pavement brightness and the correct distribution of this brightness become the criterion of good lighting. Where light on buildings or porches is objectionable, it should be refracted or reflected into the street. Some light on buildings and in the trees is necessary in the reduction of glare by lessening the contrast between the luminaire and its background. Such light also adds to the cheerfulness of the street. Sidewalk lighting with minimum shadows is necessary, and a certain amount of light between buildings is essential for protective purposes.

Definite decision on the type of luminaire, accessory, and lamp size cannot be made without due consideration of spacings and mounting heights. In business districts standards are usually located in a balanced or opposite order at frequent intervals for the sake of appearance and in order to provide a fairly uniform distribution of light both on the building facades and the pavement. The ratio of spacing to mounting height may be as low as four to one.

On other streets it is the customary practice to locate one or two lamps at the street intersections and to divide the distance between intersections into equal lengths, locating a lamp in each division. These distances vary with the amount of light to be supplied and the character of the street to be lighted. The ratio of spacing to mounting height may often be as high as eight to one but is usually better if less. Larger lamps at longer spacings are considered better practice than smaller lamps at frequent intervals. This arrangement tends toward better pavement brightness and is more economical.

Mounting heights are usually decided upon by observation as to the best appearance of the equipment and the best lighting effects, taking into account the type of post and luminaire selected. Low standards usually require closer spacing in order to preserve the proper distribution of light without incurring undue glare. On tree-bordered streets, notwithstanding judicious and reasonable trimming of trees, it is often necessary to mount lamps lower than otherwise would be desired. In general, mounting heights are increased as the size of lamps is increased. Other things being equal, there is a tendency to mount lamps lower, as diffusing globes of large area are employed.

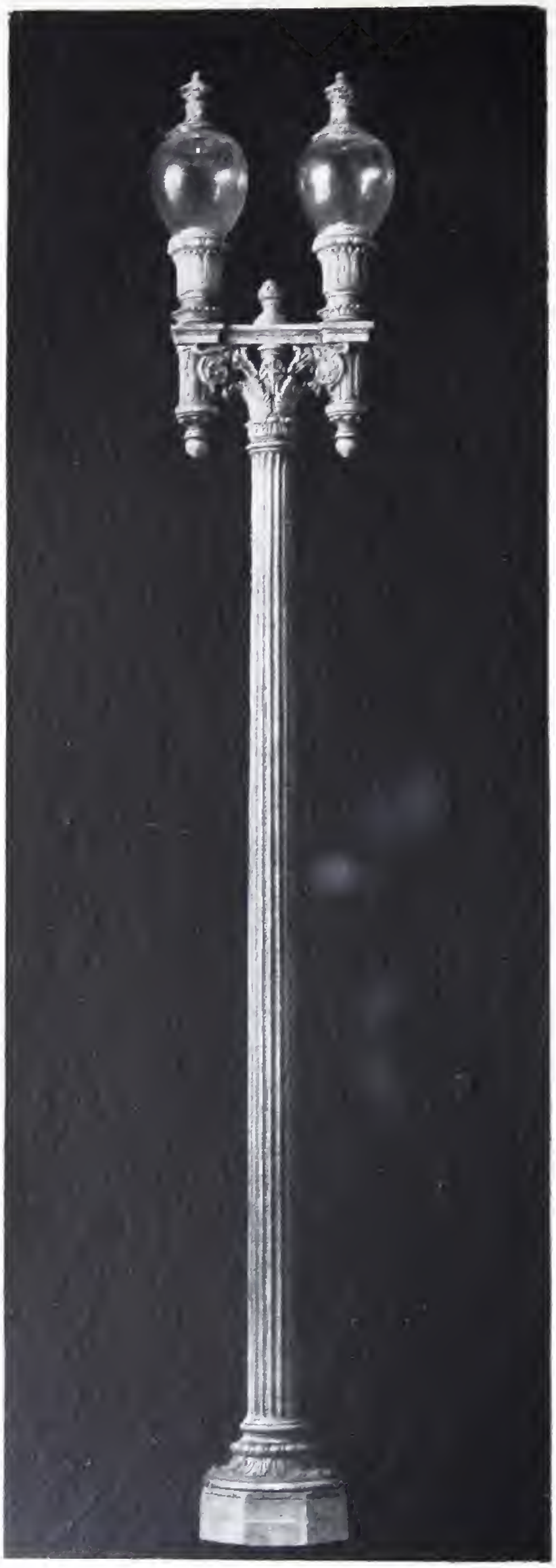
The first step in designing a lighting system is to zone the city; obtain a large map of the entire city and lay out the streets in accordance with the following subdivisions:

I. Primary Business Streets.
II. Secondary Business Streets.
III. Primary Traffic Arteries.
IV. Secondary Traffic Arteries.
V. Residential Streets and Park Drives.
VI. Highways and Undeveloped Sections.

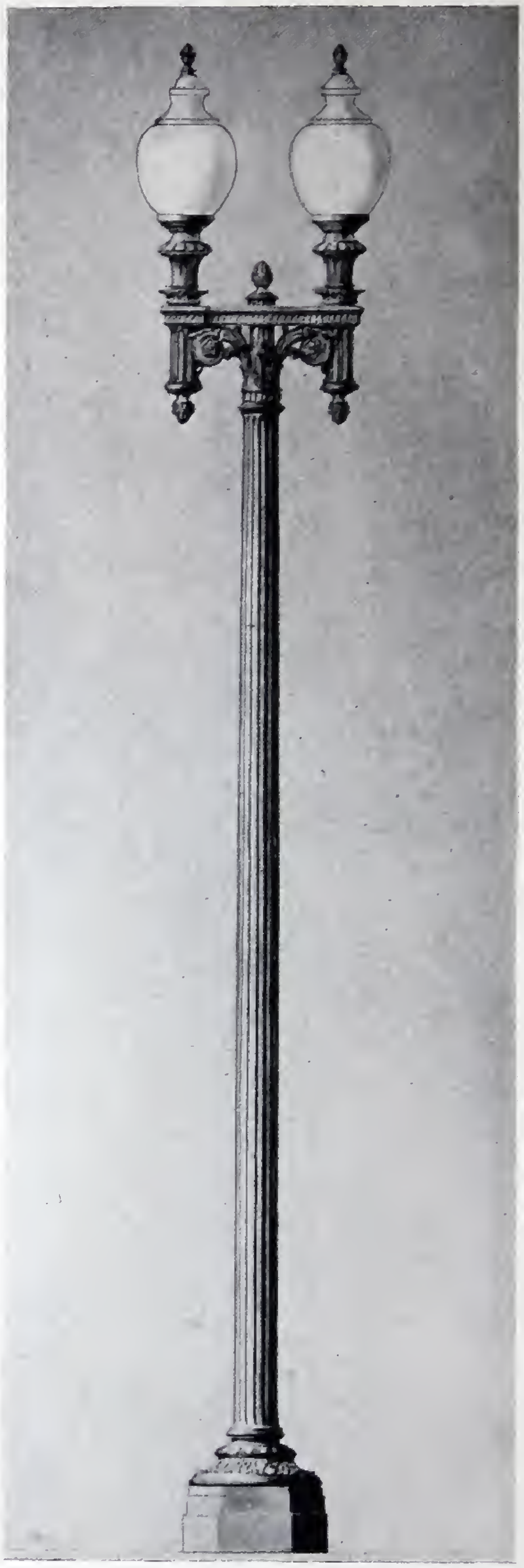
Some classifications may include manufacturing and wholesale districts, but these may usually be placed under traffic arteries or secondary business streets.

If a city plan is available, this classification work is greatly simplified; if not, the lighting map must necessarily become the city plan. Expert advice is desirable in connection with this work. Planning for the future is economical, even though it may seem extravagant for the present.

The term *lumens per linear foot*, which is used most often in classifying street lighting, is a measure of light output and while it does not take into account the proportion of light that reaches the street surface, it is a convenient measure of the comparative value of systems when used in connection with properly designed street lighting. This value is easily obtained by dividing the total bare-lamp lumens of each standard by the number of linear feet of street per standard, or the total lumens of all the lamps by the linear feet of street lighted.



6.6-ampere Luminous Arcs



15,000-lumen MAZDA Lamps

Designs for Ornamental Street Lighting Standards and Units for the National Capitol, Washington, D. C.

In Washington, D.C., the Many Circles and Prominent Streets, other than Business Streets, are Lighted by this Novalux Unit on this Two-light, 20-foot Standard

There seems to be a wide-spread demand for a set of ready-reference tables for the planning of street lighting in conformity with correct practice. Necessarily such tables must be general in character with sufficient latitude in recommendations to take care of the variables such as street widths, traffic densities, foliage conditions, and available funds.

The recommendations on pages 8 and 9 are offered as a summary of hundreds of observations by the writer in most of the large cities of this country combined with the verbal and written comments along the same lines by prominent American street-lighting engineers. It is hoped that their publication will initiate investigation and discussion which will ultimately result in the preparation of even more concrete and explicit recommendations that will tend to standardize American street-lighting practice.

It is true that the illumination of a relatively small proportion of the streets of this country equals the values recommended. Yet it is also well known that the great majority of our streets are woefully underlighted for traffic conditions existing to-day. A few of our progressive cities are installing lighting on all streets in accordance with the values herein suggested and many more are contemplating such improvements.

In the accompanying tables the low figures in general represent minimum values that should be used on narrow streets; whereas, the high figures conform to the best practice for wide streets. Local conditions will dictate the position between the upper and lower limits to be assigned to a given street. When necessity demands that a street be lighted to an intensity below that recommended, provision should be made during installation for future increases in illumination so that it can be brought up to standard without undue expense.

In Washington and in several other cities with comprehensive lighting plans, the so-called "Architectural Family" of standards has been adopted. This means that eventually the entire

(*Turn to page 11*)

A Typical Residential-street Standard in Washington, D.C.

GENERAL RECOMMENDATIONS FOR STREET LIGHTING

Table I

Primary Business Streets

Ornamental Lighting, Wiring Underground	Classification by Population		
	Over 100,000	30,000 to 100,000	Less than 30,000
Lumens of Lamps	15,000 to 45,000	10,000 to 25,000	6000 to 15,000
Lamps per Standard	2	1 or 2	1 or 2
Arrangement of Standards	Opposite on wide streets—staggered on narrow.		
Feet of Street per Standard	50 to 75	40 to 75	40 to 75
Lumens per Linear Foot	600 to 2000	300 to 800	120 to 400
Height of Upright Unit	20 to 30	18 to 25	15 to 20
Height of Pendent Unit	25 to 30	20 to 30	20 to 25

Table II

Secondary Business Streets

Ornamental Lighting, Wiring Underground	Classification by Population		
	Over 100,000	30,000 to 100,000	Less than 30,000
Lumens of Lamps	15,000 — 25,000	10,000 — 15,000	6000 — 10,000
Lamp per Standard	1		1
Arrangement of Standards	Opposite on wide streets—staggered on narrow.		
Feet of Street per Standard	50 to 75	40 to 75	40 to 75
Lumens per Linear Foot	300 to 500	150 to 300	60 to 150
Height of Upright Unit	15 to 18 ft.	15 to 18 ft.	15 to 18 ft.
Height of Pendent Units	20 to 25 ft.	20 to 25 ft.	20 to 25 ft.

Table III

Traffic Arteries

Ornamental or Semi-ornamental Lighting, Wiring Underground and Overhead	Classification by Population		
	Over 100,000	30,000 to 100,000	Less than 30,000
Lumens of Lamp	6000—15,000	6000 — 10,000	6000
Lamps per Standard	1 or 2	1	1
Arrangement of Standards	Staggered except on very wide streets.		
Feet of Street per Standard	75 to 150	100 to 150	100 to 150
Lumens per Linear Foot	60 to 200	40 to 100	40 to 60
Height of Upright Unit	15 to 18 ft.	15 to 18 ft.	15 to 18 ft.
Height of Pendent Unit	20 to 25 ft.	20 to 25 ft.	20 to 25 ft.

Secondary arteries will usually take the lowest rating.

GENERAL RECOMMENDATIONS FOR STREET LIGHTING

Table IV
Residential Streets—Not Thoroughfares

Ornamental and Semi-ornamental Lighting, Underground and Overhead Wiring	Classification by Population		
	Over 100,000	30,000 to 100,000	Less than 30,000
Lumens of Lamps	2500 to 6000	2500 to 6000	2500 to 6000
Arrangement of Standards	Staggered	Staggered	Staggered
Feet of Street per Standard	60 to 150	75 to 200	100 to 200
Lumens per Linear Foot	20 to 40	15 to 30	10 to 20
Height of Upright Unit	13 to 18 ft.	13 to 18 ft.	13 to 18 ft.
Height of Pendent Unit	18 to 25 ft.	18 to 25 ft.	18 to 25 ft.

Outlying districts and partially developed sections with little traffic are usually best lighted by fairly large-size pendent units at long spacings (300 to 500 ft.), or more numerous small units where there is tree interference. Units are usually installed as the demand arises so that it is hardly worth while attempting to make the installation conform to a given standard.

Table V
Industrial and Warehouse Sections Not on Traffic Arteries

Pendent Lamps Usually Overhead Wiring	Classification by Population		
	Over 100,000	30,000 to 100,000	Less than 30,000
Lumens of Lamps	6000 to 15,000	6000 to 15,000	2500 to 10,000
Arrangement of Lamps	Staggered	Staggered	Staggered
Feet of Street per Standard	200 to 500	200 to 500	200 to 500
Lumens per Linear Foot of Street	20 to 50	15 to 50	10 to 30
Height of Pendent Unit	20 to 25 ft.	20 to 25 ft.	18 to 25 ft.

Table VI
Highways Outside of City Limits

Pendent Lamps Overhead Wiring	Classification		
	Wide and Heavy Traffic	Narrow and Heavy Traffic	Narrow and Light Traffic
Lumens of Lamp	2500 to 10,000	2500 to 6000	2500
Arrangement of Lamps	Staggered	Staggered (preferred)	One Side
Feet of Street per Lamp	150 to 200	200 to 300	250 to 300
Lumens per Linear Foot	15 to 50	10 to 30	8 to 10
Height of Pendent Unit	25 to 35 ft.	20 to 30 ft.	20 to 30 ft.

When units especially designed for confining light to the road surface are used, smaller lamps will suffice. Where illumination is also necessary on sidewalks and cross streets with the greater amount on the pavement, the larger lamps are needed.

Examples of the Ornamental Treatment of Trolley Poles Which Must Also Serve as Street Lighting Standards

city will be illuminated by standards and fixtures of similar design, varying only in height, size, and output, depending on the character of the street on which they are located. Provision is always made in the local transformers or in the circuit for increasing the intensity on any street by changing to a lamp of the next larger size.

In the case of Washington, the designs of both fixtures and standards had to be approved by the Commission of Fine Arts. This approval was obtained only after many conferences; first over sketches, then scale models, and finally full-size models. Therefore, the designs as approved incorporate the ideas of a group of America's greatest architects, artists, and sculptors. Certainly they are worthy of consideration by every city contemplating a new system of street lighting.

JUDGING STREET LIGHTING

In the selection of the lighting equipment, perhaps the main items to consider are costs, appearance, illumination, and depreciation. The table below shows in more detail what goes to make up these items and suggests weighing factors that might be used if an accurate comparison of several systems of lighting is to be compiled for a main traffic artery. Some changes in weighing factors would be necessary for other locations. Usually an accurate comparison is unnecessary if the selection is to be made by one with some experience in judging lighting systems.

Costs

The total installation cost of each type of fixture, including everything from the source of current supply to the lamp, should be calculated and the full rating given to the one that costs the least. Others should then be rated proportionately.

Operation and maintenance should include lamp renewals, labor of cleaning and lamping, breakage of glassware and lamps, patrolling, repairs to line, standard and fixture, substation expense, overhead cost, and energy cost.

Appearance

The daylight appearance of the pole and fixture with various backgrounds should be considered.

At night the architectural form of the fixture should be preserved. The globe or lantern should appear well-filled with light from all

BASIS FOR COMPARISON OF ORNAMENTAL STREET-LIGHTING SYSTEMS FOR TRAFFIC ARTERIES

Costs	30	Installation	15
		Operation and maintenance	15
Appearance	30	Daylight, of standard and fixture	10
		Night, of fixture	10
		General, of entire street at night	10
Illumination	30	Ability to see	20
		On street	8
		At street intersection	3
		On intersecting street	3
		On sidewalk	2
		House numbers	2
		Between houses	2
		Absence of glare	10
		From street	6
		From sidewalk	2
		From house	2
Depreciation	10	Ability to stay clean	5
		Ability to stay in adjustment	5

Figures indicate percentage allotment or weighing factor for each fixture.

Each item should be rated on a scale of 100 with regard to each characteristic. A final rating will then be derived by multiplying the rating of each characteristic by its weighing factor given in the above table and dividing by 100.

6.6-ampere Ornamental Luminous-arc Lamps on Erie Boulevard, Schenectady, N. Y.

angles. It should be a lighting decoration and not merely a source of light.

The general impression as you ride or walk through the street is important. Is the effect a happy one or one that depresses you? Notice not only the street surface, but the background, the trees, the shrubbery, the houses, and the line of lights. It takes all of these to make a street. The light on the background decreases glare and increases your ability to see.

Illumination

The intensity of light on an object can be measured with a photometer but is of small importance. The light that you see by is that which actually enters the eye, for it is this that determines the brightness of the retinal image. If this sensation could be measured with an instrument it would be of great value. This quality of light is dependent on the opening through which it comes or the diameter of the

Two Form 12 Novalux Units
on a Single Standard

The Hollywood Standard with Two
Form 18 Novalux Lanterns

More than Fifteen Thousand of These Two or Similar Standards Are at Present Installed
in Los Angeles and Vicinity

pupil of the eye which is influenced by the brilliancy of the light sources or other bright objects in the line of vision. For this reason photometric readings on a street are not true indications of one's ability to see and are useless except in determining distribution characteristics or depreciation. The brightness of the pavement and the distribution of this brightness are of prime importance, for it is against this bright background that we see objects in silhouette. Often a street pavement appears brightest at its point of minimum illumination as expressed in foot-candles, the brightness being the cumulative reflections of many distant lamps.

One's ability to see from the various view-

Superior Avenue, Cleveland, Ohio

With the old lighting system, eight people were killed at night in one year. There was not a single night fatality during the first two years after this new lighting system with 25,000-lumen lamps was turned on

points suggested can be determined only after a long series of observations with different conditions of traffic and weather. Specific tests, such as the legibility of printing or the quickness of picking up objects of various shapes, are of some consequence but not nearly so valuable as the general impressions of competent observers. Your state of mind should be about the same as it would be if you were casually driving through the street and not intent upon picking up some particular object. In other words, the eyes should not be fixed but allowed to wander about as much as they naturally would.

The general lighting of the street itself is of prime importance but especial attention should be paid to the intersections, for it is at these points that we have the great dangers of cross traffic.

Next in order is the light thrown by the corner standards on these intersecting streets.

On account of the slow-moving traffic of the sidewalk very little light is needed but large dense shadows are objectionable.

It is essential that there be sufficient light on the fronts of houses to read house numbers and sufficient between houses to insure protection from criminals.

Glare is not only detrimental to vision and offensive but extremely dangerous. There are more automobile night accidents resulting from glare than from any other cause. Anti-glare headlight laws are being generally enforced and care should be taken not to counteract the benefits of such laws by introducing glare in the street lights. Glare from the street is a source of danger, but from the sidewalk or front porch mainly an annoyance. Good lighting is possible without glare and impossible with it.

Depreciation

Comparative tests on various lighting systems should extend over a long period of time with the equipment in all stages of depreciation due

Novalux Highway Units on Atlantic City Highway

to the accumulation of dirt and lack of adjustment. Inasmuch as time is not usually available for such an investigation, fixtures should be evaluated for depreciation based on data that may be at hand and a study of the qualifications of each.

Some fixtures are washed by the rains, others are streaked. The less glass surfaces between the lamp filament and the street, the less chances there will be for dust, soot, etc., to settle and absorb light.

Fixtures equipped with reflectors and refractors may or may not be sensitive to changes in adjustment, depending on the nature of the device. If a change in adjustment changes the light distribution, it is possible that the character and quality of the illumination may be depreciated.

These explanations of the table may be regarded as advice to those who would judge a lighting system. Judgment should not be passed on only a few samples, as it is the accumulative effect of a long line of standards that really counts. Installations of all modern illuminants are usually available in nearby cities and it is far less expensive and more satisfactory to visit such installations than to attempt to duplicate them on a small scale in your own city.

Manufacturers of lamps and lighting equipment have spent huge sums in preparing exhibits where one in a few hours can see the principles of street lighting demonstrated both in miniature and by full-size installations. Perhaps more will be gained by viewing one of these factory demonstrations than from any other source. The manufacturer is successful because he has been able continually over a period of many years to supply apparatus and service which have been satisfactory to his customers. So my advice to those who would select street-lighting equipment is to consult with the engineers and lighting specialists of the recognized successful manufacturers.

HIGHWAY LIGHTING

While it is intended that this paper shall deal primarily with the lighting of streets within the city limits, it would be incomplete without some mention of highway lighting. Because of the increased speed and also the proximity of opposing traffic lanes with the resultant danger from headlight glare, serious accidents to the occupants of automobiles are more common on the highway than on the city street. That traffic can be speeded up safely and with more comfort to the driver under properly designed systems of illumination has been conclusively proved on many highways.

Form 12 Novalux with Polycase Globe and Canopy of the Same Materal

Large Form 18 Novalux Lantern-type Unit with Clear Stippled Glass Panels

Form 9 Novalux with Rippled Glass Globe and Canopy

Form 13 Novalux with Plain Diffusing Globe and Canopy

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New Orleans, La	837 Gravier Street
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Niagara Falls, N. Y.	201 Falls Street
Oklahoma City, Okla	15 North Robinson Street
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Rochester, N. Y.	89 East Avenue
St. Louis, Mo	112 North Fourth Street
Salt Lake City, Utah	200 South Main Street
San Antonio, Tex	201 Villita Street
San Francisco, Calif	235 Montgomery Street
Schenectady, N. Y.	1 River Road
Seattle, Wash	811 First Avenue
Spokane, Wash	421 Riverside Avenue
Springfield, Ill	504 East Monroe Street
Springfield, Mass	1387 Main Street
Syracuse, N. Y.	113 South Salina Street
Tacoma, Wash	1019 Pacific Avenue
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